APPI
Atmospheric Pressure Processing for Industrial Solar Cells

Project Duration: 09.2015 to 12.2018
Final report submitted: 03.2019

Publishable Summary

The photovoltaics industry is on a track of fast efficiency and quality increases while reducing the production costs as much as possible. The rapid signs of progress are linked to strong pressure on innovation. Therefore, the retention of a PV industry in Europe depends on Europe's capacity to lead global PV innovation. This project brings together European PV industries, small to medium enterprises (SME) and research institutes, to develop high-efficiency Passivated Emitter and Rear Cell (PERC) solar cells, manufactured using low-cost atmospheric pressure (AP) processing.

Three key atmospheric pressure processes have been developed for low-cost high-efficiency solar cells fabrication:

- *Advanced texturing*: innovative texture based on atmospheric dry etching (ADE) allowing for low reflection on multicrystalline Si wafer and compatible with diamond wire-sawn surfaces. This process is a valuable alternative to plasma texture as it does not require strong greenhouse gas (use F_2 instead of SF_6) and reduce the power consumption as it is an atmospheric process.
- *High-efficiency emitter*: The doping source of this emitter is a phosphorus silicate glass (PSG) obtained by atmospheric pressure chemical vapour deposition (APCVD). In order to increase the performance of the emitter, a selective emitter approach is followed. The use of this special doping source allowed for independent control of the PSG properties, the drive-in process and the laser diffusion process. It also allows for a stacked drive-in process where wafers are stacked during the drive-in process effectively increasing the throughput.
- *AP passivation*: This process is based on a unique innovative deposition tool which enables direct Atmospheric Pressure Plasma Enhanced Chemical Vapour Deposition (AP-PECVD) using a homogeneous dielectric barrier discharge (DBD). The silicon nitride layer developed within this project proved to be compatible with PERC solar cell technology.

Three key processes are implemented in state-of-the-art PERC production leading to efficiency exceeding 20% on multicrystalline Si wafers and 21% on monocrystalline Si wafers. The fabricated solar cells are implemented into a specially designed module adapted to reduce the cells to module losses. The mini-modules produced during this project have been validated within standard tests under IEC 61215, sequence C and sequence D.

Project consortium

Coordinator and all contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	3	1'671'116	1'419'471
France	1	550'044	199'814
Spain	1	75'000	75'000
United Kingdom	1	345'974	207'585
Ireland	1	n.a.	0
Total	*7*	*2'642'134*	*1'901'870*

Funding agencies involved and contracts

Funding Agency	**Contract N° and Title**
Projektträger Jülich	0325895A, "Koordination, Texturierung und Integration in den Solarzellenprozess"
ADEME	1505C0004 APPI
MINECO	PCIN-2014-045
Innovate UK	620111 ERA- SOLAR APPI
Projektträger Jülich	0325895B, "Entwicklung von Hocheffizienzemittern auf Basis von APCVD Dotierquellen"